

# **LIFE TIME OF STANDARD EGYPTIAN OILS FOR VISCOSITY**

*M. Mekawy, N.I. El-Sayed*

**National Institute for Standards**

Tersa St. P. O. Box: 136 Giza, Code. No. 12211, El-Haram, Egypt

## **ABSTRACT**

The world – wide introduction of quality assurance system is connected with the increasing application of measuring technology to a great number of industrial processes and with certification which ensures that the measuring instruments used are traced back to national standards.

In the field of viscosity this leads to an increasing demand for certified reference materials, and among other things, for standard viscosity specimen.

To meet this demand and to ensure tracability to national standards an ever-increasing number of countries certify viscosity standards and disseminate these standard to the users of viscosity measuring instruments as a secondary calibration liquids and may in many cases allow a reduction of uncertainty of measurement.

The study of Egyptian viscosity oils ranging from (33) mm<sup>2</sup>/s to nearly (5000) mm<sup>2</sup>/s was previously carried out. Here we will study the life time of these oils. The life time of the standard oil can be ended by either of the three properties; the first is its separation to more than one layer, the second is to lose its viscosity and properties and the third is to become very viscous. So the study of Egyptian standard oils was extended to certify its life time. This study was done by measuring the viscosity through three years and its stability on heating was examined. The stability of viscosity against temperature was studied. The Kinematic viscosity was determined at 20, 25, 40 and 80 °C, then it was tested again at 20 °C. The measurements were carried out using standard viscometers and water bath, its temperature stability was tested and found to be  $\pm 0.02$  °C. The maximum variation of the viscosity was found to be stable within  $\pm 1\%$  mm<sup>2</sup>/s which is within the uncertainty of measurements. This means that the oils are still stable and its viscosity returned to its original measured value.

The long-term stability of the above oils with time and temperature was tested. The measurements of kinematic viscosity with temperature were measured at 20, 25, 40 and 80 °C every three months till the end of the three year using standard viscometers and found to be stable with  $\pm 2$  mm<sup>2</sup>/s which is within the uncertainty of measurements. This means that the oils are stable with time, which is one of the important properties of the standard oils.

From the above measurements it can be concluded that the viscosity of the Egyptian oils which were tested through three years are stable with temperature and time and can be recommended that the examined oils can be used as standard reference viscosity oils for calibration of viscometers for a period of three years.

## **1. INTRODUCTION:**

The NIS service for the calibration of glass capillary viscometers, rotary and other types of viscometers have been in existence for many years. This needs liquids with certified viscosities with stated uncertainties and find a source of supply of stable transparent Newtonian liquids.

The stability with time of the viscosity values of reference standards is very important for the improvement of the accuracy and the reliability of viscosity measurements. Unfortunately, owing to the variation of the chemical composition of employed fluids, the certified viscosity

values may be valid until the bottle containing a standard liquid is kept unopened at room temperature and traceable to freshly distilled water viscosity value at 20 °C by means of the viscosity scale maintained by NIS [4]

In the past cooperative and extensive viscosity work [1, 2, 3, 5] has been devoted to establish the time stability of some reference liquids. These exercises were based on periodical viscosity measurements of several sets of the standards at the same temperature and extended over several years.

The investigation work described here was carried out with periodical viscosity determinations, during more than three years, of thirteen mineral additive – free oils at several temperatures. The Procedure applied was meant to bring about a rapid change of viscosity by thermally accelerated action on the tested liquid.

The experimental results concerning the tested mineral oils are examined with particular attention given to the stability with time of viscosity.

## **2. APPARATUS**

The viscosities were determined with the viscometers immersed in temperature-controlled water baths. Two Standard Platinum Resistance Thermometers (SPRT) were used to establish the temperature of the water bath, they had a calibration history extending over some years. Shortly before each set of viscosity determinations was made, the corrections to the thermometer readings were re-determined. Measurements of the temperature uniformity of the baths showed that temperature fluctuations and accuracy of determination of the thermometer corrections would not introduce an absolute temperature error greater than 0.02 °C.

Timing was carried out by using electronic watch, which is with manually operated and periodically calibrated at NIS time and frequency lab.

## **3. EXPERIMENTAL PROCEEDURE**

### **Viscosity Measurements**

For this study thirteen mineral oils without additive were used in the nominal kinematics viscosity range from 33 to 5000 mm<sup>2</sup>/s as given in table (1). This table gives the different oil samples used in this study as supplied from the Egyptian company.

**Table (1): The oil samples used in this study.**

Company Name	Oil Name
Cooperation Group	1(50-80)
	2 (140-160)
	3(260-290)
	4(54mahaly)
	5(12Gharb)
Esso Standard	6(90/110)
	7(260/290)
	8(600/700)
	9(B-Stock)
Alexandria Company	10 Light Normal Oil (LNO)
	11 Medium Normal Oil (MNO)
	12 Heavy Normal Oil (HNO)
	13 (B-Stock)

The set was for oil testing at regular intervals (about every three months) in about three year to build up a history on each of the oil.

Before each set of measurement the oils were checked for the separation to more than one layer and if the separation occur the sample was rejected.

If there are any traces of suspensions it must be filtered then the measurements' were carried out.

The kinematics viscosity of the oils contained in these bottle sets was determined at 20 °C, 25 °C, 40 °C, 80 °C and again at 20 °C.

The kinematic viscosity measurements of all liquids at the tested temperatures were determined according to the capillary viscometer method. [D445, IP 71.]

All viscometers were previously calibrated against the PTB reference standard oils the combined standard uncertainty associated with viscometer constants were within 0.1%. The same pair of viscometers have been used to determine the repeated viscosity measurements on a particular oil. Hence a more accurate measurement of change of viscosity with time is established without introducing viscometer calibration uncertainties.

#### **4. RESULTS**

- Stability of viscosity of oils samples with time is given in Table 2
- At various intervals of time, samples are taken from each bottle and viscosity is measured at 20, 25, 40 and 80 °C and again at 20 °C the results are given in tables 2 to 4.

**Table (2) : Samples of Cooperation Group at 20°C.**

Samples @ 20°C	Viscosity for the first measurements @ 20°C	Viscosity for the second measurements @ 20°C	Viscosity for the third measurements @ 20°C	Viscosity for the forth measurements @ 20°C	Change of viscosity Per year %
1(50-80)	33.246	33.365	33.820	34.235	0.99
2 (140-160)	83.273	84.282	84.333	84.539	0.51
3(260-290)	164.011	164.953	165.803	166.105	0.43
4(54mahaly)	1575.483	1583.575	1628.281	1628.425	1.12
5(12Gharb)	4788.351	4789.356	5009.415	5015.309	1.58

**At 25°C.**

Samples @ 25°C	Viscosity for the first measurements @ 25°C	Viscosity for the second measurements @ 25°C	Viscosity for the third measurements @ 25°C	Viscosity for the forth measurements @ 25°C	Change of viscosity per year %
1(50-80)	26.860	26.979	27.051	27.175	0.39
2 (140-160)	62.172	63.658	63.6960	63.803	0.87
3(260-290)	117.624	118.605	120.846	120.989	0.95
4(54mahaly)	1017.96	1019.109	1044.625	1046.893	0.95
5(12Gharb)	3031.860	3038.107	3112.998	3125.827	1.03

**At 40°C.**

Samples @ 40°C	Viscosity for the first measurements @ 40°C	Viscosity for the second measurements @ 40°C	Viscosity for the third measurements @ 40°C	Viscosity for the forth measurements @ 40°C	Change of viscosity per year %
1(50-80)	14.841	14.858	14.947	15.159	0.71
2 (140-160)	30.638	31.358	31.699	31.972	1.45
3(260-290)	54.312	54.405	54.517	54.825	0.31
4(54mahaly)	336.623	337.105	340.370	342.529	0.58
5(12Gharb)	934.813	934.813	945.462	949.352	0.52

**At 80°C.**

Samples @ 80°C	Viscosity for the first measurements @ 80°C	Viscosity for the second measurements @ 80°C	Viscosity for the third measurements @ 80°C	Viscosity for the forth measurements @ 80°C	Change of viscosity per year %
1(50-80)	4.990	5.037	5.139	5.273	1.89
2 (140-160)	8.276	8.472	8.575	8.798	2.10
3(260-290)	12.027	12.481	12.587	12.829	2.22
4(54mahaly)	46.511	47.548	47.609	47.923	1.01
5(12Gharb)	92.189	92.189	92.364	92.837	0.23

**Table (3) : Samples of Esso Standard Company at 20°C.**

Samples @ 20C	Viscosity for the first measurements @ 20C	Viscosity for the second measurements @ 20°C	Viscosity for the third measurements @ 20°C	Viscosity for the forth measurements @ 20°C	Change of viscosity per year %
6(90-110)	54.802	55.399	55.110	56.997	1.34
7(260-290)	161.513	161.755	161.077	162.829	0.27
8(600-700)	386.120	386.610	395.783	397.824	1.01
9(B-Stock)	2017.487	2025.790	2026.429	2026.953	0.16

**At 25°C.**

Samples @ 25C	Viscosity for the first measurements @ 25C	Viscosity for the second measurements @ 25°C	Viscosity for the third measurements @ 25°C	Viscosity for the forth measurements @ 25°C	Change of viscosity per year %
6(90-110)	42.358	42.924	43.631	44.319	1.54
7(260-290)	117.624	118.525	119.166	119.898	0.68
8(600-700)	275.106	275.165	279.451	282.395	0.89
9(B-Stock)	1336.110	1342.955	1344.043	1346.893	0.27

**At 40°C.**

Samples @ 40°C	Viscosity for the first measurements @ 40°C	Viscosity for the second measurements @ 40°C	Viscosity for the third measurements @ 40°C	Viscosity for the forth measurements @ 40°C	Change of viscosity per year %
6(90-110)	21.904	22.340	22.808	23.025	1.71
7(260-290)	52.778	52.889	53.136	53.618	0.53
8(600-700)	112.921	113.995	114.600	115.323	0.71
9(B-Stock)	440.353	444.410	445.019	445.925	0.42

**At 80°C.**

Samples @ 80°C	Viscosity for the first measurements @ 80°C	Viscosity for the second measurements @ 80°C	Viscosity for the third measurements @ 80°C	Viscosity for the forth measurements @ 80°C	Change of viscosity per year %
6(90-110)	6.456	6.922	6.959	7.105	3.35
7(260-290)	12.134	12.268	12.874	13.319	3.26
8(600-700)	25.716	27.822	28.158	28.985	4.24
9(B-Stock)	59.189	59.559	60.189	61.012	1.03

**Table (4) : Samples of Alex Company at 20°C.**

Samples @ 20C	Viscosity for the first measurements @ 20C	Viscosity for the second measurements @ 20°C	Viscosity for the third measurements @ 20°C	Viscosity for the forth measurements @ 20°C	Change of viscosity per year %
10(L.N.O)	72.901	73.452	73.654	73.809	0.42
11(M.N.O)	242.911	244.221	250.730	253.928	1.51
12(H.N.O)	471.006	472.350	473.562	475.367	0.31
13(B-Stock)	1518.557	1520.559	1529.498	1535.320	0.37

**At 25°C.**

Samples @ 25C	Viscosity for the first measurements @ 25C	Viscosity for the second measurements @ 25°C	Viscosity for the third measurements @ 25°C	Viscosity for the forth measurements @ 25°C	Change of viscosity per year %
10(L.N.O)	55.863	56.501	57.164	57.321	0.87
11(M.N.O)	175.396	175.798	180.001	183.923	1.62
12(H.N.O)	312.545	312.601	314.607	316.892	0.46
13(B-Stock)	997.856	997.958	1023.309	1025.562	0.93

**At 40°C.**

Samples @ 40°C	Viscosity for the first measurements @ 40°C	Viscosity for the second measurements @ 40°C	Viscosity for the third measurements @ 40°C	Viscosity for the forth measurements @ 40°C	Change of viscosity per year %
10(L.N.O)	27.242	27.448	27.576	27.973	0.89
11(M.N.O)	74.510	74.668	76.578	77.393	1.29
12(H.N.O)	128.281	128.911	129.559	130.425	0.56
13(B-Stock)	332.085	339.459	340.289	341.527	0.95

**At 80°C.**

Samples @ 80°C	Viscosity for the first measurements @ 80°C	Viscosity for the second measurements @ 80°C	Viscosity for the third measurements @ 80°C	Viscosity for the forth measurements @ 80°C	Change of viscosity per year %
10(L.N.O)	7.525	7.568	7.978	8.115	2.61
11(M.N.O)	14.649	15.522	15.95	17.205	5.82
12(H.N.O)	23.397	23.655	24.045	25.329	2.75
13(B-Stock)	45.662	46.605	47.045	48.105	1.78

## **5 CONCLUSIONS**

The stability of reference materials plays an important role in the performance and in the reliability of measurements. It is the responsibility of NIS to give calibration certificate with the validity period for this standard reference material. This stability give an information about the limitation period of validity of this standard reference Egyptian oils. Thirteen Egyptian transfer viscosity standard oils have been tested by following a procedure involving periodical viscosity determine during three years at several temperature.

From table (2) it is clear that the maximum variation is about 1.6% at 20 °C which is within the uncertainty of the measurements for Cooperation Group company.

From table (3) it is clear that the maximum variation is about 1.3% at 20 °C which is within the uncertainty of the measurements for Esso Standard company.

From table (4) it is clear that the maximum variation is about 1.5% at 20 °C which is within the uncertainty of the measurements for Alexandria company.

Thirteen NIS transfer viscosity standards have been tested by following a procedure involving periodical viscosity determinations during three years at several temperatures.

From Table 2 it is clear that the maximum variation is about 1% which is within the uncertainty of the measurements A rapid change in all the regularly tested liquids with an increase of viscosity was observed, although viscosity variations with time were small enough when the samples were stored in sealed bottles under usual laboratory conditions. The results justify the usual limited validity time of viscosity transfer standards issued by metrological organizations. The tested Egyptian Standard oils can used for a period of three years.

## **REFERENCES**

1. Dabon, J.E., The NPL reference oils for viscosity, Meas. & Control 18, IM+C (1985), 226-232.
2. J. E. Dabron The NPL viscosity scale. Metrologia 11, 79-84 (1975).
3. Kurano, Y., International comparison of the kinematic viscosity of the ASTM standard oil samples at -40 °C and 100 °C, Proc. 6<sup>th</sup> Japan Symp. On Thermo physical Prop., (1985), 29-32.
4. M.M. Mekawy, F.M. Megahed, N.I. El-Sayed National Institute for Standard Realization of National Viscosity Scale in Egypt Submitted for NIS-MSS 2001.
5. Salvatore Lorefice, Mario Rasetti CNR-Istituto di Metrologia 'G. Colonnti' Investigation into time stability of viscosity transfer standards. International Tribology Conference, Yokohama 1995.

## **Addresses of the Authors**

National Institute for standard Thermometry Department Tersa St., El-Haram – Giza - Egypt  
Email [nismail\\_2000@yahoo.com](mailto:nismail_2000@yahoo.com), [m\\_mekawy@yahoo.com](mailto:m_mekawy@yahoo.com)  
Internet: <http://www.nis.sci.eg> OR <http://www.193.227.27.133>